CLAIMS

(57) [Claim(s)]

[Claim 1]A needle type display which drives a display indicator with a step motorcomprising:

a time check which clocks set time -- a means.

said time check -- computing time long [whenever a means clocks timea difference of a directions position which said display indicator tends to make it directand a current position to which the present display indicator is pointing is brief at the adult timeand] when a difference is smallness -- said time check -- a time check set to a means -- a time calculating means.

said time check -- a sub-pulses generating means which generates sub pulses of M individual and drives a step motor in a cycle of a drive pulse which a time calculating means computed.

A drive pulse judging means which judges whether said drive pulse changes to 1 from 0 at the time of a start of a cycleor it changes to 0 from 1A duty ratio change means which makes a duty ratio of sub pulses small gradually when judged with making large gradually a duty ratio of a pulse generated in said sub-pulses generating means when judged with a drive pulse changing to 1 from 0 by said drive pulse judging means at the time of a start of a cycleand changing to 0 from 1.

[Claim 2]M sub pulses generated in said sub-pulses generating means are generated at equal intervals in a cycle of a drive pulseThe needle type display according to claim 1 making 0% a duty ratio of sub pulses of the last changed by said duty ratio change means when a drive pulse changes to 1 from 0 and it changes to 0 from 1 100%.

[Claim 3]The needle type display according to claim 1 or 2 characterized by making it generate inside of a cycle of a drive pulse for sub pulses generated in

said sub-pulses generating means for every fixed time.

DETAILED DESCRIPTION

[Detailed Description of the Invention]

[0001]

[Industrial Application]This invention relates to the needle type display which drives a display indicator with a step motor.

[0002]

[Description of the Prior Art]Drawing 9 (A) shows the step motor 10 of four phasesand comprises the rotor 10a and the stator 10b. The rotor 10a is constituted magnetically and the display indicator is attached to the axis of rotation via GYA.

[0003]If current flows into the phase phi 1 of the stator 10b as shown in drawing 9 (B)the south pole will occura suction force occurs between the n poles of the rotor 10athe rotor 10a rotates to itand phi 1 is faced between (0 degree of drawing 9 (B)). If pulse applying is carried out to phi 2 in this statei.e.the state where the pulse was impressed to phi 1it will become a synthetic magnetic field of phi1 and phi2the south pole will occur in the mid-position of phi1 and phi2and the magnetic field generated from the stator 10b will rotate 45 degrees of rotors 10a clockwise (45 degrees of drawing 9 (B)).

[0004]It rotates 45 degrees of rotors 10a at a time one by one by impressing a pulse to phi1-phi4 hereafteras shown in drawing 9 (B). as for the motor 10a drive pulse is inputted -- a display indicator is not illustratedalthough it is alike and 45 degrees rotates -- gear down is carried out to aarghbe alikeand it becomes rotation of the degree of $theta_0$.

[0005]directions position $theta_M$ which it is going to direct to every fixed time T in the conventional needle type display as shown in drawing 10and current position $theta_P$ to which the present indicator is pointing -- $N=(theta_M-theta_P)/theta_0$ ... (1)

Drive pulse N is computed by performing the becoming operation.

[0006]when the drive pulse N [several] is computedit is shown in drawing 10 (A) -- as -- T_A -- N drive pulses are sent out with a time interval. Namelywhen rotating a pulse motor clockwise nowsupposing the present pulse motor is in the position which is 0 degree of drawing 9 (B)In time $t_1$phi1=0 and the drive pulse which becomes phi2=1 are sent out for phi1=1 and the drive pulse which becomes phi2=1 by t_2 after T_A timeand a step motor is rotated.

[0007]For this reasonthere was no deflection of an indicator until the No. 1 pulse computed the following cycle T was sent outafter the No. N pulse sent out the deflection of the indicatorand the indicator changed stair-like and was not a smooth motion. The method of smoothing deflection of this indicator is indicated to JP64-6556U.

[0008]This method makes T/N the outpulsing interval which sends out N pulses in the cycle Tand delays sending out of the first pulse time T / 2Nand he is trying to send it outas shown in drawing 10 (B). Thusa motion of an indicator becomes smooth by controlling the transmission start time and the transmission time interval of a pulse.

[0009]It will be $T/N>=T_A$ if the minimum outpulsing time interval that the step operation for which it opts from the characteristic of a step motor here can follow is made into T_A... (2)

moreover -- since said outpulsing interval is equalized and the first pulse is delayed -- drawing 10 (B) and a formula (2) -- T>= / $2NT_A$ ... (3)

Thereforeit turns out that the value of T is made smaller than a certain numerical value.

[0010]

[Problem(s) to be Solved by the Invention]In the needle type display driven with a step motoralthough a drive pulse is sent out with the time interval more than the time of the minimum which the step operation of a step motor can followit is required that a response [as opposed to change of an input signal in the transmission timing in that case] should be a smooth response at best moreover.

[0011]Vehicles gather speed graduallyindicating angle theta$_M$ of drawing 11 acceleratesand an example in the case of being fallen and attached to constant speed is shown. A solid line makes T_A the minimum time interval that the step operation of a step motor can followOperation of the deflection of the indicator at the time of making it operate by the method indicated by JP64-6556U when the cycle T shown by drawing 10 considers it as $T=6T_A$ and $T=12T_A$ is shown.
[0012]Although smoothness improves by this method** In order to change the outpulsing interval to every [which a response delay generates in the whole region since calculus-of-finite-differences appearance is made every cycle T] ** cycle T. As shown by A of drawing 9an abrupt change occurs and smoothness is lost. ** ** in which ** and ** will get worse further if the cycle T is made large -- as mentioned abovemoreover the cycle T is not made smaller than a certain numerical valuechange of an input signal is various and setting out of the cycle T which is adapted for all the change is quite difficult -- there is a problem of **.
[0013]That isarithmetic control is carried out for every predetermined time unit like conventional technologyi.e.calculus-of-finite-differences appearance cannot be performed to every cycle Tand it can be incompatible with the prompt response mentioned above as long as it was a method to which an outpulsing interval is changed in smooth operationand smoothness is also insufficient.
[0014]Whenever a drive pulse is inputted into a pulse motoran indicator theta-$_0$-moves. the drive pulse which drives a step motor rises rapidlyand tells rotation of an indicator and a step motor to an indicator -- aarghthe inertia of ** is also addedand movement of an indicator generates a vibration phenomenonas the solid line of drawing 12 shows.
[0015]Movement of an indicator of this invention is smoothand it aims at providing the needle type display improved so that a response might also become smooth well.
[0016]
[Means for Solving the Problem]In order to solve the above-mentioned technical problema means which this invention adopted is explained. Before explaining a

means which an invention solved firsta principle which loses vibration of an indicator generated in a standup and falling of a drive pulse of this invention is explained with reference to drawing 8.

[0017]Drawing 8 (A) shows a drive pulse impressed to each phase phi_n explained by drawing 9 (B). A drive pulse comprises drive pulse c which falls from drive pulse a which rises to 1 from 0drive pulse b holding 1and 1 to 0.

[0018]Since why the indicator 12 vibrates is produced when a pulse rises rapidly or falls like the drive pulse a or cIn the case of a standupas shown in drawing 8 (B)M sub pulses are generated in bottom of cycle T_P of a drive pulseand moreoverit makes the duty ratio large gradually.

[0019]In the case of fallingas shown in drawing 8 (C)M sub pulses are generated in periodic T_P of a drive pulseand moreoverit makes the duty ratio small gradually. By doing in this waya drive of a step motor is eased and movement of an indicator becomes smooth.

[0020]Interval T_S which sub pulses generate sets up the sub pulses M [several] become an interval smaller enough than operating time of a step motor. Although it was made to generate M sub pulses in periodic T_P of a drive pulse in drawing 8 (B) and (C) as a method of easing a drive of a step motorIn drawing 8 (D)into periodic T_P of a drive pulsesub pulses are generated for every time T_C smaller than driving time of a step motorthe duty ratio is changedand movement of an indicator is made smooth.

[0021]A means which this invention adopted with reference to drawing 1 next is explained. Drawing 1 is a basic constitution figure of this invention. needle type display **** which drives a display indicator with a step motor -- a time check which clocks set time -- with the means 1. said time check -- whenever the means 1 clocks timea difference of a directions position which said display indicator tends to make it directand a current position to which the present display indicator is pointing is brief at the adult timeandcomputing time long when a difference is smallness -- said time check -- a time check set to the means 1 -- with the time calculating means 2. said time check -- with the sub-pulses

generating means 3 which generates sub pulses of M individual and drives a step motor in a cycle of a drive pulse which the time calculating means 2 computed. The drive pulse judging means 4 which judges whether said drive pulse changes to 1 from 0 at the time of a start of a cycleor it changes to 0 from 1A duty ratio of a pulse generated in said sub-pulses generating means 3 when judged with a drive pulse changing to 1 from 0 by said drive pulse judging means 4 at the time of a start of a cycle is gradually made largeWhen judged with changing to 0 from 1it has the duty ratio change means 5 which makes a duty ratio of sub pulses small gradually.

[0022]A duty ratio of sub pulses of the last which generates M sub pulses generated in said sub-pulses generating means 3 at equal intervals in a cycle of a drive pulseand is changed by said duty ratio change means 5 is made 0%when a drive pulse changes to 1 from 0 and it changes to 0 from 1 100%.

[0023]It is made to generate inside of a cycle of a drive pulse for sub pulses generated in said sub-pulses generating means 3 for every fixed time.

[0024]

[Function]a time check -- the means 1 -- a time check -- the time which the time calculating means 2 computed is clocked. a time check -- the time calculating means 2 -- a time check -- the difference of the directions position which you are going to make it direct with an indicator for every time for the means 1 to clockand the current position to which the indicator is pointing is brief at the adult timeand long time is computed when a difference is smallness.

[0025]the sub-pulses generating means 3 -- a time check -- in the cycle of the drive pulse which the time calculating means 2 computedthe sub pulses of M individual are generated and a step motor is driven. It is judged whether the drive pulse judging means 4 changes to 0 from whether a drive pulse changes to 1 from 0 at the time of the start of a cycleand 1.

[0026]The duty ratio change means 5 makes large gradually the duty ratio of the pulse generated in the sub-pulses generating means 3when judged with a drive pulse changing to 1 from 0 at the time of the start of a cycleand when judged with

a drive pulse changing to 0 from 1it makes the duty ratio of sub pulses small gradually.

[0027]The duty ratio of the sub pulses of the last which generates generating of M sub pulses generated in the sub-pulses generating means 3 at equal intervals in the cycle of a drive pulseand is changed by the duty change means 5 is made 0%when a drive pulse changes to 1 from 0 and it changes to 0 from 1 100%.

[0028]It is made to generate the inside of the cycle of a drive pulse for generating of the sub pulses generated in the sub-pulses generating means 3 for every fixed time. As mentioned abovecalculation of the difference of the directions position which you are going to make it direct with an indicatorand the current position to which the present indicator is pointingIt is made to compute after time long [the difference computed last time is brief at the adult timeand] when a difference is smallnessA drive pulse is sent out to a step motor after the computed timeThe duty ratio of M sub pulses generated in a cycle when a drive pulse rises at the time of the start of the cycle of a drive pulse is gradually made largeSince it was made to make a step motor drive as the duty ratio of M sub pulses is gradually made small when a drive pulse fellA rapid standup and a falling drive are eased and the oscillating rotation by inertia is lostand movement of an indicator can be smoothand a response can also be goodand it can be made to move smoothly.

[0029]Generating of M sub pulses is generated at equal intervals in the cycle of a drive pulseSince the duty ratio of sub pulses was made to change so that it may become 100% about the duty ratio of the last sub pulses and may become 0% in the case of falling when a drive pulse was a standupmovement of an indicator can be made smooth.

[0030]Since it was made to generate the inside of the cycle of a drive pulse for generating of sub pulses in a certain time intervalan indicator can be moved smoothlywithout needing high-speed processing.

[0031]

[Example]One example of this invention is described with reference to drawing 2 - drawing 5. The lineblock diagram of the example of this inventiondrawing 3 -

drawing 4 of drawing 2 are the operation flow charts of the example. In drawing 210 a step motor and 11 a scale and 12 An indicator13 -- a current position primary detecting element and 14 -- a directions position computation part and 15 -- a time check -- a time calculation part. 16 -- a time check -- as for a part and 17a sub-pulses generating part and 19 are a duty ratio change partand a drive pulse sending part and the processor (CPU) whose 21-23 a time counter and 24 perform a counter26-28 interface (I/O)and process 29 20 a drive pulse judgment part and 18.
[0032]The example shown by drawing 2 makes the example the case where speed is displayed with the indicator 12 based on the signal from the run sensor which sends out a pulsewhenever vehicles carry out a unit distance run I/O26. With reference to drawing 5operation of the directions position computation part 14 is explained first.
[0033]As for operation of the directions position computation part 14whenever a traveling pulse is inputted from I/O26operation is started by interrupt processing. In the processing S31difference with the time into which the time when the pulse was inputted from I/O26 last time was inputted this time is computed.
[0034]By the processing S32it is theta$_M$=K$_B$/t... (4)
howeverK$_B$ -- a constant -- theta$_M$ is computed by calculating.
[0035]That isin the processing S32speed is computed from the pulse interval inputted from I/O26and angle-of-rotation theta$_M$ of the indicator 12 on the scale 11 corresponding to the computed speed is computed. In the processing S33it records on the memory which does not illustrate directions position theta$_M$ computed by the processing S32and processing is ended.
[0036]As mentioned abovewhenever a pulse is inputted from a run sensorthe directions position computation part 14 computes a new shelf directions positionand breaks record. With reference to drawing 3 and drawing 4operation of an example is explained below. the processing S1 -- a time check -- the part 16 judges whether the counted value of the time counter (T$_P$) 21 is 0and it stands by until counted value is set to 0.

[0037]That istime T_P computed by the processing S5 explained later was setand the time counter (T_P) 21 was operated as a down counterand has detected time T_P. the processing S2 -- a time check -- reading current position theta$_P$ to which the time calculation part 15 reads directions position theta$_M$ which the directions position computation part 14 is computing and recordingand the indicator 12 is pointing now via I/O27 from the current position primary detecting element 13 --
theta=theta $_M$-theta$_P$ ... (5)
performing the becoming operation -- difference -- theta is computed.
[0038]the processing S3 -- a time check -- the difference which computed the time calculation part 15 by the processing S2 -- judging whether theta is 0and moving to processing S4when a judgment is YES -- the time counter (T_P) 21 -- a time check -- time T_1 is set. T_1 -- a value is explained later. the processing S5 -- a time check -- the time calculation part 15 -- T_P=|K_A/theta|+K_C--- (6)
howeverK$_A$ and K$_C$ -- a constant -- calculating -- a time check -- time (cycle of drive pulse) T_P is computedit shifts to the processing S6T_P is set to the time counter (T_P) 21and a time check is made to start (drawing 8 (A))
[0039]By the processing S7the sub-pulses generating part 18 is T_S=T_P/M... (7)
Periodic T_S of sub pulses is computed by performing the becoming operation (drawing 8 (B)(C)). In the processing S8the drive pulse judgment part 17 judges phase phi$_n$ which sends out a drive pulse.
[0040]namelythe difference computed by the processing S2 as drawing 9 (B) explained -- it being made to rotate clockwise and a step motorwhen theta is positive. The present state needs to make it phi1=0phi2=1phi3=1and phi4=0for making it 135 degrees next at 90 degrees (phi1=0phi2=1phi3=0phi4=0) of drawing 9 (B).
[0041]In the processing S8phase phi$_n$ which sends out a drive pulse next from the hand of cut of a step motor and the present state is determined. At processing S9the sub-pulses generating part 18 is a counter. [M]24 is cleared to 0and it shifts to the processing S10and is a counter. [M]Periodic T_S of the sub pulses which carried out counted value of 24 +1shifted to the processing S11and

were computed by the processing S7 to the time counter (T_S) 22 is setand a time check is made to start.

[0042]By the processing S12the duty ratio change part 18 is T_D=(T_S/M) x to the time counter (T_D) 23. [M]... (8)

It corrects[M] is a counter. [M] -- counted value -- T_D which calculated is set and a time check is made to start

[0043]In the processing S13the drive pulse judgment part 17 judges whether drive pulse sending-out phase phi_n judged by the processing S8 changes to 1 from 0 in the starting point of a cycleand whether it changes to 0 from 1. To the phase from which a drive pulse changes to 1 from 0 in the starting point of a cycleit shifts to the processing S14and a drive pulse moves to the end point of a cycle at the processing S19 to the phase which changes to 0 from 1.

[0044]The sub-pulses generating part 18 makes 1 output to the step motor 10 via I/O28 in the processing S14 from the drive pulse sending part 20. In the processing S15the sub-pulses generating part 18 judges whether the time counter (T_D) 23 which it was set by the processing S12 and has been clocked ended the time checkWhen the time check is not completedshift to the processing S141 is made to output to a step motor succeedingly and a time check is completedit shifts to the processing S16and it is a counter. [M]It judges whether the counted value of 25 is Mand when a judgment is NOit shifts to the processing S17 and 0 is outputted to a step motor.

[0045]When it stands by until it endedwhen it judged whether the time counter (T_S) 22 which the sub-pulses generating part 18 was set by the processing S11 at the processing S18and has been clocked ended the time check and the time check was not completedand it endsit shifts to the processing S10 and the following sub pulses are generated.

[0046]Namelyas drawing 8 (B) showsby the processings S11 and S18 periodic T_S of sub pulsesTime [for sub pulses to send out 1 by the processings S12 and S15] T_D is generatedthe set value of the processing S12 is changedand the duty ratio of sub pulses is enlarged gradually.

[0047]The processings S19-S22 are the generation processings of sub pulses in case the drive pulse corresponding to drawing 8 (C) changes to 0 from 1in the processing S190 is outputted to a step motorand 1 is outputted in the processing S22. In the processing S23when judged with their being the last sub pulses in the processing S16 and 211 or 0 sent out to the step motor now is heldand it shifts to the processing S1and the sub-pulses generating part 18 starts the next indicator movement.
[0048]as mentioned abovethe difference theta of directions position $theta_M$ and current position $theta_P$ -- time it is large -- a time check -- the time of making brief time made to clock in a partand theta being smallness -- a time check -- the characteristic with a sufficient response is smoothly obtained by lengthening time and sending out a drive pulse. Since an error becomes large from the position to which the position which the indicator 12 directs sends out a drive pulse at the time of |theta|=0 is pointing nowthe reason for making it judge by the processing S3 whether it is |theta|=0 stops sending out of a drive pulseand he is trying to make it re-judge at T_1 second.
[0049]T_1 -- although a value can be set up arbitrarilythe directions position computed by ****** in the directions position computation part 14 by setting up T_1 small in the meantime is changed -- difference -- even if theta occursan indicator can be promptly moved to a directions position and a response can be improved. What is necessary is just to set the judgment by the processing S3 to $|theta|<theta_0/2$when unit angle $theta_0$ which an indicator rotates by the drive of the difference theta computed by the formula (5) and a step motor is not an integer.
[0050]In operation when directions position $theta_M$ changes a lot suddenlyrevolving speed $dtheta_P/dt$ of current position $theta_P$ is
$dtheta_P/dt=theta_0/T_S=|(theta_M-theta_P)\ theta_0/K_A|$... (9)
When the differential equation of a next door and an equation (9) is solvedit is
$theta_P=theta_M\ (1-\exp\ [-theta_0 t/K_A])$... (10)
It becomes.

[0051]That isas the dotted line of drawing 11 showstheta$_P$ moves to theta$_M$ exponentially smoothly and promptly. Since a step motor is driven by the sub pulses which changed the duty ratioas the dotted line of drawing 12 showsit rotates smoothly.
[0052]Belowwith reference to drawing 6 and drawing 7operation of the example corresponding to drawing 8 (D) is explained. Operation of drawing 6 and drawing 7 performs same operation except the processing S7 and S11 which were explained by drawing 3 and drawing 4and S12.
[0053]processing S7' which changes to the processing S7 -- the sub-pulses generating part 18 -- $M_A=T_P/T_C$--- (11)
Sub-pulses several M $_A$ which drives by performing the becoming operation is computed. T_C is a cycle of sub pulses and is set as a value sufficiently smaller than the operating time of a step motor.
[0054]processing S11' which changes to the processing S11 -- the time counter (T_S) 22 -- a time check -- time T_C is set and a time check is made to start At processing S12' which changes to the processing S12it is $T_D=(T_C/M)$ x to a time counter (T_D). [M]... (12)
T_D which performed the becoming operation is set and it is made to start with a time check.
[0055]By making it operate as mentioned abovedrive sub pulses as shown by drawing 8 (D) occurand a step motor is rotated smoothly.
[0056]
[Effect of the Invention]According to this inventionthe following effect is acquired as explained above. Calculation of the difference of the directions position which you are going to make it direct with an indicatorand the current position to which the present indicator is pointingIt is made to compute after time long [the difference computed last time is brief at the adult timeand] when a difference is smallnessA drive pulse is sent out to a step motor after the computed timeThe duty ratio of M sub pulses generated in a cycle when a drive pulse rises at the time of the start of the cycle of a drive pulse is gradually made largeSince it was

made to make a step motor drive as the duty ratio of M sub pulses is gradually made small when a drive pulse fellA rapid standup and a falling drive are eased and the oscillating rotation by inertia is lostand movement of an indicator can be smoothand a response can also be goodand it can be made to move smoothly.
[0057]Generating of M sub pulses is generated at equal intervals in the cycle of a drive pulseSince the duty ratio of sub pulses was made to change so that it may become 100% about the duty ratio of the last sub pulses and may become 0% in the case of falling when a drive pulse was a standupmovement of an indicator can be made smooth.
[0058]Since it was made to generate the inside of the cycle of a drive pulse for generating of sub pulses in a certain time intervalan indicator can be moved smoothlywithout needing high-speed processing.

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1]It is a basic constitution figure of this invention.
[Drawing 2]It is a lineblock diagram of the example of this invention.
[Drawing 3]It is an operation flow chart of the example.
[Drawing 4]It is an operation flow chart of the example.
[Drawing 5]It is an operation flow chart of the example.
[Drawing 6]It is an operation flow chart of other examples.
[Drawing 7]It is an operation flow chart of other examples.
[Drawing 8]It is a figure for explaining the principle of operation which loses vibration of the indicator of this invention.
[Drawing 9]It is a figure explaining the drive of a step motor.
[Drawing 10]It is an explanatory view of a conventional example of operation.
[Drawing 11]It is a figure explaining movement of the indicator of a conventional example.

[Drawing 12]It is a figure explaining movement of the indicator of a conventional example.

[Description of Notations]

1 a time check -- a means

2 a time check -- a time calculating means

3 Sub-pulses generating means

4 Drive pulse judging means

5 Duty ratio change means

10 Step motor

11 Scale

12 Indicator

13 Current position primary detecting element

14 Directions position computation part

15 a time check -- a time calculation part

16 a time check -- a part

17 Drive pulse judgment part

18 Sub-pulses generating part

19 Duty ratio change part

20 Drive pulse sending part

21 - 23 time counter

24 Counter

26-28 Interface (I/O)

29 Processor (CPU)